Central Valley Fall-Run Chinook Salmon

(*Oncorhynchus tshawytscha*)

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Status

Federal: Candidate (64 Federal Register [FR] 50394, September 16, 1999)

State: None

Other: None

Recovery Plan: None

Placer Legacy Category: Class 1

Distribution

North America

There are probably over a thousand spawning populations of Chinook salmon on the North American coast from Southeastern Alaska to California (Healey 1991). Chinook salmon is one of the most abundant salmon species in North America.

California

The Central Valley fall-run evolutionarily significant unit (ESU) includes fall-run and late-fall–run Chinook salmon in the Sacramento and San Joaquin Rivers and their tributaries.

Placer County Phase I Planning Area

Historical

The Bear River supported a fall run that ascended as far as present day Camp Far West Reservoir, where a waterfall probably hindered further passage (Yoshiyama et al. 1996). In the 1950's, there were up to a thousand salmon spawning in the Dry Creek system, about 10 percent of which used Miners Ravine (Finlayson 1977 in DWR 2002).

Current

The Bear River supports an occasional run of adult fall-run chinook salmon in years when flows are sufficient to provide passage (Yoshiyama et al. 1996).

Adult salmon carcasses have been observed in Antelope Creek, Miners Ravine, and Secret Ravine in the late fall (CALFED Bay-Delta Program 2000). Adult salmonid spawning surveys conducted during fall/winter, 2000-2002, in Linda and Cirby creeks, in Roseville, identified Chinook carcasses, redds, and live fish each year (GANDA 2002). For example during the 2001/2002 fall/winter they enumerated 30 adult fish, 19 redds, and 51 carcasses in Linda Creek. During the same period the Dry Creek Conservancy observed 188 adult fish and 73 carcasses in the Dry Creek watershed and tributaries, minus Linda Creek (GANDA 2002). The juvenile salmonid monitoring conducted between February – May 2002 yielded 4 juvenile Chinook salmon in Cirby and Linda creeks (GANDA 2002).

In addition, wild juvenile fall-run chinook salmon have been found in small numbers in Coon Creek; Doty Creek; Auburn Ravine; and the upper creek watersheds of Dry Creek, including Secret Ravine, Antelope Creek, and Miners Ravine (CALFED Bay-Delta Program 2000).

It has been reported that juvenile salmon raised in the Feather and American River hatcheries have been stocked in several streams (including Coon Creek, Auburn Ravine, and tributaries of Dry Creek) since 1983, but there appear to be no records of the numbers and dates of these plants.

Population Status & Trends

California

The most abundant populations of fall-run Chinook salmon occur in the Sacramento, Feather, Yuba, and American Rivers (Mills and Fisher 1994). The ESU also occurs in smaller tributaries of the Sacramento River and in tributaries of the San Joaquin River. Fall-run Chinook salmon have a relatively large hatchery component, averaging more than 25,000 adults. Natural spawners average about 200,000 adults for the Sacramento and San Joaquin systems (Moyle 2002).

Placer County Phase I Planning Area

In 1963 and 1964, California Department of Fish and Game surveys indicated that 300–800 wild fall-run Chinook salmon spawned successfully in Secret Ravine. Hatchery juveniles from the Feather and American Rivers have been stocked in Coon Creek, Auburn Ravine, and tributaries of Dry Creek since 1983 (CALFED Bay-Delta Program 2000).

Natural History

Habitat Requirements

Chinook salmon are dependent upon suitable water temperature and substrate for successful spawning and incubation. Although the suitability of gravel substrates for spawning depends largely on the fish size, a number of studies have determined substrate sizes that represent the most suitable conditions. Generally, Chinook salmon require substrates of approximately 0.3–15 centimeters (cm) (0.1–5.9 inches), whereas steelhead prefer substrate no larger than 10 cm (Bjornn and Reiser 1991).

The quality of spawning habitat is also correlated with intra-gravel flow. Low intra-gravel flow may provide insufficient dissolved oxygen, contribute to growth of fungus and bacteria, and result in high levels of metabolic waste. High percentage of fines in gravel substrates can substantially limit intra-gravel flow, affecting the amount of spawning gravel available in the river (Healey 1991). Raleigh et al. (1986) concluded that optimal gravel conditions would include less than 5–10% fine sediments measuring 0.3 cm (0.12 inch) or less in diameter. In addition, alevins of Chinook salmon, steelhead, and coho salmon have been observed in laboratory studies to have difficulty emerging when gravels exceeded 30–40% fine sediments (Bjornn 1968; Phillips et al. 1975 in Bjornn and Reiser 1991; Waters 1995).

Water depth is one factor affecting spawning gravel selection (Raleigh et al. 1986; Bjornn and Reiser 1991). Minimum water depths at redd areas vary with fish size and water velocity, because these variables affect the depth necessary for successful digging (Healey 1991). In general, water depth should be at least deep enough to cover the fish during spawning. Burner (1951 in Healey 1991 and Bjornn and Reiser 1991) observed Chinook salmon spawning in water as shallow as 5 cm (0.16 foot); Vronski (1972 in Healey 1991) found Chinook salmon spawning in water depths of 720 cm (23.6 feet). Thompson

(1972 in Bjornn and Reiser 1991), who also studied water depth requirements for spawning, found Chinook salmon spawning in depths less than 24 cm (0.8 foot).

Flow velocity also affects spawning gravel selection; however, the range in water depth and velocity is very broad (Healey 1991). Healey found water velocities of 30–189 cm/second (0.98–6.2 feet/second) reported in the literature. Studies in northern California found that Chinook salmon from the Yuba and Sacramento Rivers preferred velocities of 47.2–89.9 cm/second (1.55–2.95 feet/second) and 27.4–82.3 cm/second (0.9–2.7 feet/second) respectively (California Department of Fish and Game 1991).

Survival of Chinook salmon eggs and larvae during incubation declines as water temperatures increase to 12–16ºC (53.6–60.8ºF) (Myrick and Cech 2001).

Rearing habitat for salmonids is defined by environmental conditions such as water temperature, dissolved oxygen, turbidity, substrate, area, water velocity, water depth, and cover (Bjornn and Reiser 1991; Healey 1991; Jackson 1992). Environmental conditions and interactions among individuals, predators, competitors, and food sources determine habitat quantity and quality and the productivity of the stream (Bjornn and Reiser 1991). Rearing habitat for juvenile chinook salmon includes riffles, runs, pools, and inundated floodplain.

Use of floodplain habitat by juvenile Chinook salmon has been well documented (California Department of Water Resources 1999; Sommer et al. 2001). Sommer et al. (2001) found that floodplain habitat provides better rearing and migration habitat for juvenile salmon than does the main river channel. The growth rate of Chinook salmon in the Yolo bypass was generally higher than the growth rate in the main channel of the Sacramento River. The faster growth rate in the Yolo Bypass may be attributed to increased prey consumption associated with greater availability of drift invertebrates and warmer water temperatures. Invertebrate production on the floodplain may be stimulated by availability of detritus in the food web, available habitat for benthic invertebrates, and a relatively long hydraulic residence time. Long residence time reduces the rate at which nutrients and drifting invertebrates are flushed out of the system.

Survival of juvenile Chinook salmon declines as water temperatures increase to 18–24ºC (64.4–75.2ºF). Juveniles require cooler water temperature to complete the parr-smolt transformation and to maximize their saltwater survival. Successful smolt transformation deteriorates at temperatures of 17–23ºC (62.6–73.4ºF).

Reproduction

Central Valley Fall-run Chinook salmon spawn from late September to December, with peak spawning taking place during late October and November when water temperatures decrease (Moyle 2002). Fall-run Chinook salmon spawn over gravel (redds) soon after arriving at their spawning grounds. Juvenile fish remain in redds from about 32 days at 16ºC (61°F) to 159 days at 3ºC (37°F) (Healey 1991).

Dispersal Patterns

After emerging from gravel, juvenile Chinook salmon move downstream, mostly at night. They rear in the mainstem rivers or the Delta before migrating to the ocean.

Longevity

Chinook salmon generally mature at 3–4 years and can reach 5–8 years (Healey 1991). A minority of individuals return to the river as sexually mature 2-year-olds (grilse).

Sources of Mortality

Low flows, resulting in warmer water temperatures and decreased dissolved oxygen levels, increase mortality of eggs and juvenile Chinook salmon. Egg survival is reduced when elevated water temperatures reduce oxygen availability in the gravel. Another result of increased temperatures is the threat of heightened predation by nonnative fish species; sublethal temperatures reduce growth of juvenile salmon and may increase potential predators' metabolism, thus increasing the risk of predation by centrarchids and other nonnative fish species adapted to higher water temperatures. (U.S. Army Corps of Engineers 2000.)

Entrainment at diversions is another source of mortality; low flows can confuse or detain migrating juveniles, resulting in higher entrainment at diversions.

Behavior

While in streams, Chinook salmon are opportunistic feeders and vary their diet according to seasonal availability. In the summer months, they feed primarily on drifting aquatic invertebrates, terrestrial insects, and active bottom invertebrates. Individual fish, however, do not usually feed on the full range of food available. Larger fish tend to eat larger prey. Feeding can occur any time of day, but most activity occurs around dusk. (Moyle 2002.)

After migrating to the ocean, Chinook salmon feed on estuarine invertebrates and krill. As the juvenile salmon grow, other fish constitute an increasing component of their diet. Chinook salmon's large size and rapid growth in the ocean can be attributed to a diet of fish, squid, and crustaceans. Once they return to fresh water, adult Chinook salmon stop feeding. (Moyle 2002.)

Chinook salmon occupy the freshwater system from the estuary to stream headwaters, depending on access, water temperature, and perennial flow. The distance that Central Valley fall-run Chinook salmon migrate in the ocean is unknown.

Movement and Migratory Patterns

Fall-run Chinook salmon migrate from the Pacific Ocean to the Central Valley rivers from approximately August to December. Peak spawning occurs during late October and November. Juvenile fall-run Chinook salmon start emigrating towards the Pacific Ocean from January through June, shortly after emerging from their redds.

Ecological Relationships

The predator/prey relationship between juvenile Chinook salmon and nonnative fish species has a significant effect on mortality of young salmon. Warm water temperatures cause stress and suppress growth; both conditions increase vulnerability to predators. Moreover, because nonnative fish are adapted to warmer water temperatures, their predatory efficiency is increased by the same condition that heightens the vulnerability of juvenile Chinook salmon.

Population Threats

Degradation and loss of habitat have contributed substantially to the decline of Chinook salmon. Shasta and other dams blocked access to historic spawning and rearing habitat, as it did in the case of steelhead. Other factors affecting abundance include modifications of water temperatures that result from reservoir operations, harvest, entrainment in diversions, contaminants, predation by nonnative species, and interaction with hatchery stock (U.S. Army Corps of Engineers 2000).

Low flows limit habitat area and adversely affect water quality by elevating water temperatures and depressing dissolved oxygen; these conditions stress incubating eggs and rearing juvenile fall-run Chinook salmon. Low flows may affect migration of juvenile and adult salmon; decreased depths can inhibit adult passage, and reduced velocity can impede the downstream movement of juveniles. Low flows in combination with diversions may result in higher entrainment losses (U.S. Army Corps of Engineers 2000).

In the Delta, flows drawn through the Delta Cross Channel (DCC) and Georgiana Slough transport a proportion of migrants into the central Delta. The number of juveniles entering the DCC and Georgiana Slough is assumed to be proportional to the volume of flow diverted from the Sacramento River (California Department of Fish and Game 1987). Survival of juvenile Chinook salmon drawn into the central Delta is lower than survival of juvenile Chinook salmon remaining in the Sacramento River channel.

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